

# ANALYSIS OF ARABICA COFFEE CHARACTERISTICS AND DRYING METHOD ON ARABICA COFFEE FLAVOR USING ANALYSIS OF VARIANCE

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**ABSTRACT:** This study investigated the effect of the coffee drying process using a coffee drying house on the moisture content, acidity, caffeine value, and flavour of Arabica coffee. An experimental method with a two-factor analysis of variance was used to evaluate significant differences between three different drying processes: Before Drying Process, Sun Drying Process, and Drying Process with Coffee Drying House. The results showed that sun-drying coffee with a coffee drying house produced lower moisture content, acidity, and caffeine value than the other drying processes. The flavour of Arabica coffee produced by this method was also considered sweeter by coffee export standards. Statistical analysis with Anova Block Subsampling, Anova 1 Factor Fixed Model, and Anova 2 Factor Factorial Design showed that the coffee drying process using coffee drying houses significantly affects the quality of arabica coffee. This study concludes that coffee drying houses can be an effective solution in improving the quality of Arabica coffee by controlling the moisture content, acidity, and caffeine value. The results of this study contribute to understanding the process of drying coffee beans and the factors that affect the final quality of the product. Therefore, this study provides an essential scientific basis for coffee farmers and the coffee processing industry to improve the quality of their coffee.

*Keywords: Anova Block Subsampling, Anova 1 Factor Fixed Model, Anova 2 Factor Factorial Design, Arabica Coffee Characteristics, Drying Process, Arabica Coffee Flavours*

## 1. Introduction

Coffee is one of the most popular beverages around the world today. Moisture content, acidity value and caffeine value are obtained from coffee [1,2]. Young adults in their productive years are the primary consumers of coffee. The acidity value, caffeine value, and moisture content in coffee can be used to assess the quality of a cup of coffee [3,4]. The three elements that affect coffee quality are acidity, caffeine and moisture content. The sour taste of coffee is caused by acidity, caffeine, and moisture content, which is one of the ingredients that gives coffee a bitter taste [5,6]. Consuming coffee can relieve sleepiness and fatigue. On the other hand, excessive caffeine intake can also hurt health, affecting behaviour, cardiovascular problems, and calcium absorption [7]. Coffee contains acids, both volatile and non-volatile, which contribute to its acidity in addition to caffeine. These acids help flavour coffee [8].

Good coffee's caffeine, acidity, and moisture content should not be too high or too low.

Consumption of coffee with high caffeine, acidity and low water content can cause digestive problems, especially the release of stomach acid [9]. Consuming caffeine has two negative effects. Caffeine has adverse effects on the nervous system and circulatory system and can be addictive [10]. However, coffee also has the advantage of supporting metabolism, being a source of antioxidants, and having other effects [11]. There is approximately 102-200 mg of caffeine in a cup of brewed coffee ( $\pm$  250 ml) with a standard 1-3% percentage. Coffee has a pH between 4 and 6%, therefore, if it is too acidic, it can cause damage to the coffee. In addition, the moisture content of coffee that is suitable for coffee quality ranges from 10-12.5%. Suppose the moisture content of coffee is above 12.5%. In that case, it can cause the coffee flavour to become bland and the resulting coffee beans to be damaged because bacteria have contaminated them [12].

One of the things that must be considered to produce quality coffee with a sweet flavour is the drying process of coffee beans. The drying of

coffee beans has the primary purpose of removing the water content in the coffee beans. It can increase the acidity degree value and reduce the caffeine value, so that the coffee beans will avoid the potential for quality deterioration in the final processing process, namely, storage in the warehouse. The deterioration or damage in question is initiated by the presence of high water in the beans, for example, causing mould or triggering the presence of warehouse pests [13]. Some fungal species can also produce certain chemical compounds that are toxic to humans, such as the ochratoxin compound caused by *Aspergillus ochraceus*. In addition to causing toxicity in coffee, fungal attack can also reduce the potential for producing flavour, so aspects of drying techniques are important to consider [14].

The people of Indonesia, especially in Karot Village, Langke Rembong Sub-district, Manggarai Regency, still dry coffee traditionally or directly under the sun with a tarpaulin in front of the house. This method is quite effective in accelerating the drying process of coffee beans. However, when the weather is rainy, the temporarily dried coffee beans will be lifted and stored inside the house. In addition, because they are dried outside in the open air, the coffee beans will be exposed to dust and bacteria. Furthermore, every 2-3 hours, the coffee beans that are temporarily dried must be checked periodically by flipping the coffee beans so that the drying process of the coffee beans can be evenly distributed. That can cause the coffee beans' high water content, acidity and caffeine levels. In addition to the traditional drying process directly under the sun, the process before drying is also important. This process is done to determine the initial condition of the coffee beans when they have just been picked from the tree [15]. In addition, when the coffee cherries are still wet, the ones picked will be sorted to separate the ripe and immature coffee cherries. Ripe coffee fruit is full red, while immature coffee fruit is pale, whitish and slightly wrinkled. The ripe coffee fruit will be washed with clean water to remove dirt and fruit residue. After washing, the coffee fruit will be put into sacks to store. After being stored for a long time, the coffee fruit will be rewashed to remove any remaining dirt [16]. The clean coffee fruit will be peeled off the skin using a huller machine to produce arabica coffee beans. Arabica coffee beans will then be dried in the sun until the moisture content reaches 10-12%.

Apart from sun drying, coffee drying can also be done using the coffee drying house drying method. The drying method with a coffee drying house can dry coffee evenly and quickly. In addition, the drying process with a coffee drying

house can be done indoors, so the coffee beans are better protected from contamination. The drying house method is carried out by drying coffee beans without horn skins that are still wet and the thickness of the beans is low so that the heat transfer rate is obtained in the process of drying the beans more evenly and evaporating water directly from the beans so that saturation does not occur which causes the beans to require higher heat (excess) to evaporate water. Sufficient and not excessive heat energy during drying will prevent unnecessary evaporation of volatile aroma-forming compounds, so that the potential aroma of coffee will be better and have a more substantial flavour potential (bold). In addition, it is necessary to analyse the effect of moisture content, acidity value, and caffeine value on the flavour of arabica coffee during the drying process to improve its quality [11].

Therefore, this research will use the experimental method with analysis of variance using Anova Block Subsampling, Anova 1 Factor Fixed Model and Anova 2 Factor Factorial Design. An experimental method using two-factor analysis of variance is a statistical approach to analyze significant differences between two or more data groups. In a research context, the rationale for using this method can be based on the need to understand the effect of multiple independent variables on a dependent variable. For example, a study on the effect of moisture content, acidity, and caffeine content on coffee flavour uses one-factor ANOVA and subsampling block ANOVA to determine whether variations in these three variables during the coffee drying process significantly affect coffee flavour.

## 2. Research Methods

The research was conducted in Karot Village, Langke Rembong Sub-district, Manggarai Regency. It was quantitative. Researchers used the fixed model variance analysis, subsampling block variance analysis, and factorial design variance analysis.

This research involves coffee farmers in Karot village, and the type of coffee studied is Arabica coffee. Arabica coffee flavour was the sole dependent variable in this quasi-experimental study, while moisture content and drying process were the two independent variables. The researcher applied three different drying processes, namely:

1. Pre-Drying Process
2. Sun-drying Process
3. Drying process with a coffee drying house.

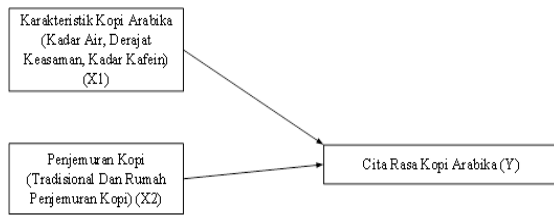


Figure 1. Framework of Thought

The research hypotheses in this study are:

H01 : There is no effect of Arabica coffee characteristics on the taste of Arabica coffee

H11 : There is an influence of Arabica coffee characteristics on the taste of Arabica coffee

H02 : There is no effect of arabica coffee characteristics on the drying process

H12 : There is an effect of arabica coffee characteristics on the drying process

H03 : There is no effect of arabica coffee characteristics and arabica coffee drying process on the taste of arabica coffee.

H13 : There is an effect of Arabica coffee characteristics and the drying process of Arabica coffee on the taste of Arabica coffee.

### 3. Results and Discussion

#### 1. Fixed Model Analysis Of Variance Before Drying

Table 5 Fixed Model Analysis Of Variance With One-Way ANOVA Before Drying

|                | Characteristics of Arabica Coffee |              |                     | Total |
|----------------|-----------------------------------|--------------|---------------------|-------|
|                | Moisture Content (%)              | Acidity (PH) | Caffeine Levels (%) |       |
| Taste (1,2, 3) | 33.5                              | 12.17        | 11.15               |       |
|                | 30                                | 13.25        | 12.85               |       |
|                | 27.4                              | 12.6         | 12.01               |       |
|                | 21                                | 14           | 11.21               |       |
|                | 26.7                              | 13.05        | 12.93               |       |
|                | 22.9                              | 12.22        | 12.07               |       |
|                | 34.8                              | 13.4         | 11.27               |       |
|                | 23.4                              | 13.8         | 12.99               |       |
|                | 25                                | 12.71        | 12.13               |       |
|                | 32.2                              | 12.5         | 11.33               |       |
|                | 34.5                              | 13.64        | 13.05               |       |
|                | 27.1                              | 14           | 12.19               |       |

|                   |             |          |             |             |
|-------------------|-------------|----------|-------------|-------------|
|                   | 30.3        | 12.9     | 11.39       |             |
|                   | 40.2        | 12.4     | 13.11       |             |
|                   | 24.8        | 13.25    | 12.25       |             |
|                   | 23.7        | 13.74    | 11.45       |             |
|                   | 41.4        | 12.02    | 13.17       |             |
|                   | 33.7        | 12.19    | 12.31       |             |
|                   | 44.4        | 12.17    | 11.51       |             |
|                   | 30.6        | 13.25    | 13.23       |             |
|                   | 33.5        | 12.6     | 12.37       |             |
|                   | 30          | 14       | 11.57       |             |
|                   | 27.4        | 13.05    | 13.29       |             |
|                   | 21          | 12.22    | 12.43       |             |
| Total             | 719.5       | 311.13   | 293.26      | 1323.89     |
| Many Observations | 24          | 24       | 24          | 72          |
| Average           | 29.97916667 | 12.96375 | 12.21916667 | 18.38736111 |

For the research hypothesis:

H0 : There is no effect of arabica coffee characteristics on the taste of arabica coffee

H1 : There is an influence of Arabica coffee characteristics on the taste of arabica coffee

$$R_y = \frac{(1323.89)^2}{72} = 24342.84$$

$$W_y = P_y = \frac{719.5^2}{24} + \frac{311.13^2}{24} + \frac{293.26^2}{24} - 24342.84 = 4843.971$$

$$\sum Y^2 = 30117.87$$

$$E_y = 30117.87 - 4843.971 - 24342.84 = 931.0545$$

Table 6 ANOVA for Data Before Drying

| Source Of Variation | df | JK | RJK | ER JK | F <sub>Coun t</sub> | F <sub>T abl e</sub> |
|---------------------|----|----|-----|-------|---------------------|----------------------|
|---------------------|----|----|-----|-------|---------------------|----------------------|

|                                   |   |      |      |                            |      |
|-----------------------------------|---|------|------|----------------------------|------|
| Average                           | 1 | 2434 | 2434 | -                          |      |
| Characteristics of Arabica Coffee | 2 | 4,84 | 2,42 |                            |      |
|                                   | 1 | 3,97 | 1,98 | $\sigma_e^2 + \sigma(M)^2$ | 5,46 |
|                                   |   |      | 6    |                            | 2,80 |
|                                   |   |      |      |                            | 6    |
| Fallacy                           | 2 | 9,31 | 4,43 | $\sigma_e^2$               |      |
|                                   | 1 | 0,54 | 3,59 |                            |      |
|                                   |   | 5    | 3    |                            |      |
| Total                             | 2 | 3011 |      |                            |      |
|                                   | 4 | 7,87 | -    | -                          | -    |

The conclusion is  $F_{\text{Count}} > F_{\text{Table}}$ , which means that the characteristics of arabica coffee have a very significant effect on its taste.

Mean Test After Anava With Newman-Keuls Test

Mean : 29,97916667;  
12,96375; 12,21916667

Treatment : 1 2  
3

RJK (Fallacy) : 3,47

dk : 21

dk=21 dan  $\alpha=0.05$

P = 2 3

Range = 3.00 3.65

P = 2 3

RST = 4.08 4.964

2 opponent 3 -> 0.745 < 4.964

1 opponent 3 -> 17.76 > 4.964

2 opponent 1 -> -17.02 < 4.08

Conclusion:

1)  $F_{\text{Count}} < F_{\text{Table}}$ , so there is no difference between treatments 2 and 3 (acidity and caffeine content) on the taste of arabica coffee.

2)  $F_{\text{Count}} > F_{\text{Table}}$  then there is a difference between treatments 1 and 3 (moisture content and caffeine content) on the taste of arabica coffee.

3)  $F_{\text{Count}} < F_{\text{Table}}$  then there is no difference between treatments 2 and 1 (acidity and moisture content) on the taste of arabica coffee.

## 2. Fixed Model Analysis Of Variance For Sun Drying

Table 7 Fixed Model Analysis Of Variance With One-Way ANOVA Sun Drying

| Characteristics of Arabica Coffee |                    |                      |       |
|-----------------------------------|--------------------|----------------------|-------|
| Moisture Content (%)              | Acidity Level (PH) | Caffeine Content (%) | Total |
| 13.2                              | 8.17               | 4.56                 |       |
| 14.1                              | 8.46               | 3.65                 |       |
| 12.8                              | 7.6                | 4.75                 |       |
| 15.3                              | 7.87               | 4.7                  |       |
| 13.7                              | 8.05               | 4.63                 |       |
| 12.9                              | 8.32               | 4.37                 |       |
| 14.8                              | 8.38               | 4.24                 |       |
| 13.4                              | 8.66               | 4.05                 |       |
| 15                                | 8.83               | 3.9                  |       |
| 12.6                              | 8.5                | 3.35                 |       |
| 14.5                              | 8.78               | 3.95                 |       |
| 13.1                              | 8.95               | 3.75                 |       |
| 15.2                              | 8.62               | 4.13                 |       |
| 12.7                              | 8.89               | 3.8                  |       |
| 14.6                              | 9.06               | 3.55                 |       |
| 13                                | 8.74               | 4.01                 |       |
| 15.1                              | 9.02               | 3.6                  |       |
| 13.5                              | 9.19               | 3.45                 |       |
| 14.4                              | 8.86               | 3.85                 |       |
| 13.3                              | 9.14               | 3.5                  |       |
| 14.9                              | 9.31               | 3.3                  |       |
| 13.5                              | 8.98               | 3.7                  |       |
| 15.4                              | 9.26               | 3.4                  |       |
| 12.6                              | 9.43               | 3.25                 |       |
| Total                             | 333.6              | 209.07               | 93.44 |
| Man                               | 24                 | 24                   | 24    |
| Obse                              |                    |                      | 72    |

| Source                | Sum of Squares | Mean Square | F     | p-value |
|-----------------------|----------------|-------------|-------|---------|
| Age                   | 13.9           | 8.71125     | 33333 | 11      |
| Gender                | 13.9           | 8.71125     | 33333 | 11      |
| Education             | 13.9           | 8.71125     | 33333 | 11      |
| Occupation            | 13.9           | 8.71125     | 33333 | 11      |
| Income                | 13.9           | 8.71125     | 33333 | 11      |
| Marital Status        | 13.9           | 8.71125     | 33333 | 11      |
| Religion              | 13.9           | 8.71125     | 33333 | 11      |
| Political Affiliation | 13.9           | 8.71125     | 33333 | 11      |
| Health Status         | 13.9           | 8.71125     | 33333 | 11      |
| Family Size           | 13.9           | 8.71125     | 33333 | 11      |
| Urban/Rural           | 13.9           | 8.71125     | 33333 | 11      |
| Employment Status     | 13.9           | 8.71125     | 33333 | 11      |
| Marital Status        | 13.9           | 8.71125     | 33333 | 11      |
| Religion              | 13.9           | 8.71125     | 33333 | 11      |
| Political Affiliation | 13.9           | 8.71125     | 33333 | 11      |
| Health Status         | 13.9           | 8.71125     | 33333 | 11      |
| Family Size           | 13.9           | 8.71125     | 33333 | 11      |
| Urban/Rural           | 13.9           | 8.71125     | 33333 | 11      |
| Employment Status     | 13.9           | 8.71125     | 33333 | 11      |

For the research hypothesis:

H0 : There is no effect of arabica coffee characteristics on the taste of arabica coffee

H1 : There is an influence of arabica coffee characteristics on the taste of arabica coffee

$$R_y = \frac{636.11^2}{72} = 5619.94$$

$$W_y = P_y = \frac{333.6^2}{24} + \frac{209.07^2}{24} + \frac{93.44^2}{24} - 5619.94 = 1202.151$$

$$\sum Y^2 = 6853.402$$

$$E_y = 6853.402 - 1202.151 - 5619.94 = 31.307$$

Table 8 ANOVA for Sun Drying Data

| Source                            | Of Variations | D | JK        | RJK     | ER JK | F <sub>Count</sub> | F <sub>Table</sub> |
|-----------------------------------|---------------|---|-----------|---------|-------|--------------------|--------------------|
| Average                           | 1             | 1 | 5619,94   | 5619,94 | -     |                    |                    |
| Characteristics of Arabica Coffee | 2             | 2 | 1,202,151 | 601,075 |       | 403,406            | 3,47               |
| Fallacy                           | 2             | 2 | 31,307    | 1,49    |       |                    |                    |
| Total                             | 2             | 2 | 6,853,402 | -       | -     | -                  | -                  |

The conclusion is  $F_{\text{Count}} > F_{\text{Table}}$ , which means that there is a very significant effect of arabica coffee characteristics on the taste of arabica coffee.

Mean Test After Anava With Newman-Keuls Test

Means : 13,9; 8,71; 3,89

Treatment : 1 2 3

RJK (Fallacy) : 3,47

dk : 21

dk=21 dan  $\alpha=0.05$

P = 2 3

Range =3.00 3.65

P = 2 3

RST =0.75 0.91

2 opponent 3 -> 4.82 > 0.91

1 opponent 3 -> 10.01 > 0.91

1 opponent 2 -> 5.19 > 0.75

Conclusion:

- 1)  $F_{\text{Count}} > F_{\text{Table}}$  then there is a difference between treatments 2 and 3 (acidity and caffeine content) on the taste of arabica coffee.
- 2)  $F_{\text{Count}} > F_{\text{Table}}$ : The taste of Arabica coffee differs between treatments 1 and 3 (moisture content and caffeine content).
- 3)  $F_{\text{Count}} > F_{\text{Table}}$ : The taste of arabica coffee differs between treatments 1 and 2 (moisture content and acidity).

## 4. Conclusions

The following are the results of data processing with a fixed model analysis of variance with one way annova, analysis of variance with a subsampling block design and by using a two way annova factorial design analysis of variance so that it can be concluded, using the drying method with a coffee drying house can produce coffee with lower moisture content, acidity, and caffeine value, as well as a sweeter taste and also the quality of coffee produced is by coffee export standards. In addition, based on the results of the research hypothesis that has been carried out, the value of the  $F_{\text{count}} > F_{\text{table}}$  test is  $545.377 > 9.55$ . The significance value is  $0.000 < 0.005$ , which means that H0 is rejected H1 is accepted, which means that the moisture content, acidity value, caffeine value and coffee drying process using a coffee drying house affect the taste of arabica coffee.

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